

# Preservation of low-frequency hearing in partial deafness cochlear implantation

H. Skarżyński, A. Lorens\*, A. Piotrowska

*International Center of Hearing and Speech of the Institute of Physiology and Pathology of Hearing,  
Warsaw, Poland*

---

**Abstract.** Partial deafness is characterised by normal or slightly elevated thresholds in the low-frequency band with nearly total deafness in higher frequencies. The aim of the study was to investigate whether the low-frequency hearing of partially deafened patients could be preserved after cochlear implant surgery applying Med-El Combi 40+ with partially inserted electrode. Cochlear implantation was performed in six partially deafened patients. Changes in auditory thresholds using pure tone audiometry recordings were measured to determine the extent of preservation of low-frequency hearing. Low-frequency hearing was preserved to the large extent in all patients. Preservation of low-frequency hearing creates the opportunity for application of electric and acoustic stimulation in the partially deafened. It could provide speech comprehension better than with either modality alone. Obtained results can be considered as the first step towards the application of cochlear implant in the treatment of partial deafness. © 2004 Elsevier B.V. All rights reserved.

*Keywords:* Cochlear implants; Residual hearing; Hearing preservation; Partial deafness; Partial deafness cochlear implantation (PDCI)

---

## 1. Introduction

There is a group of patients whose hearing impairment is characterized by normal or slightly elevated thresholds in the low-frequency band with nearly total deafness in higher frequencies. The authors proposed to describe this type of hearing impairment as partial

---

\* Corresponding author. Department of Auditory Implants and Perception, Institute of Physiology and Pathology of Hearing, 17 Mokra Str., Kajetany 05-830, Nadarzyn, Poland. Tel.: +48 22 35 60 334; fax: +48 22 35 60 367.

*E-mail address:* a.lorens@ichs.pl (A. Lorens).

deafness. Using the classification of audiometric configuration, the audiogram of a partially deaf patient is precipitously sloping. This type of audiogram is also called a “steeply sloping” audiogram. Patients in this group remain beyond the scope of effective treatment with hearing aids, since amplification at the frequencies above the region of substantial residual hearing provides little or no benefit for people with steeply sloping audiograms [1,2].

Based on the encouraging results obtained by combining electric and acoustic stimulation [3,4] and results of residual hearing preservation study [5,6], the decision to apply a cochlear implant in partially deafened patients was made [7]. The aim of this study was to investigate whether the low-frequency hearing of partially deafened patients could be preserved after cochlear implantation.

**2. Material and methods**

Six partially deaf patients implanted at the Institute of Physiology and Pathology of Hearing, and aged between 26 and 64 years old (mean age 43 years) participated in the

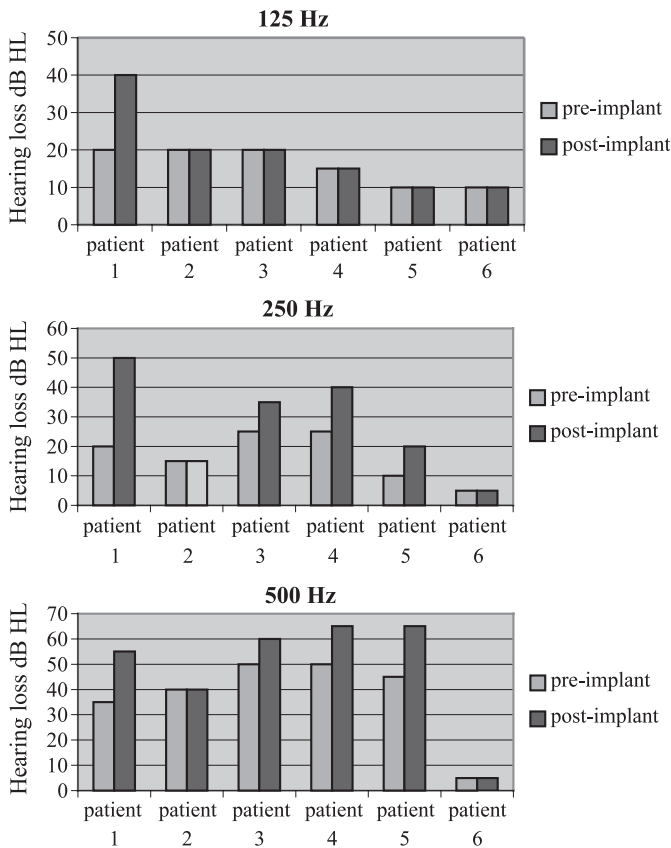


Fig. 1. Individual pre- and postoperative thresholds for frequencies 125, 250 and 500 Hz.

study. There were two males and four females. All patients were implanted with the MED-EL COMBI 40+ with partial electrode insertion through the round-window membrane (8 of the 12 electric contacts were inserted). The device was fixed in a well made in the temporal bone. To assess preservation of low-frequency hearing, preservation of pure-tone testing was performed using a Siemens SD5 audiometer calibrated according to standards established by the American National Standards Institute (ANSI 1 month before and 1 month after cochlear implantation). The individual thresholds differences were calculated for three low frequencies 125, 250, 500 Hz. An overall loss of hearing was determined by looking at the mean PTA scores.

### 3. Results

Individual pre- and postoperative threshold for frequencies 125, 250 and 500 Hz are shown in Fig. 1. The average decrement in sensitivity measured by pure tone testing was 3 dB HL for 125 Hz, 11 dB HL for 250 Hz and 12 dB HL for 500 Hz.

### 4. Discussion

Considering the fact that attenuator steps of 5 dB are employed, a minimum of  $\pm 5$  dB measurement error is introduced. Since tolerances contained in ANSI standards range from  $\pm 3$  to 5 dB of designated sound pressure levels, the standard error can potentially expand to  $\pm 10$  or 15 dB HL depending on the listener's actual physiologic sensitivity [8]. Thus, only patients having a negative threshold difference of more than 10 dB were considered as the ones who lost a certain degree of hearing following the cochlear implantation. Taking this into account we can state that in five out of six patients hearing was fully preserved at 125 Hz, in three out of six at 250 Hz, in three out of six at 500 Hz. Moreover, the changes did not exceed 30 dB at all frequencies.

Therefore, it can be concluded that the low-frequency hearing was fully preserved in two patients (30%) and in four patients to the large extent as proved by audiometric tests. Results of the present study demonstrate that the low-frequency hearing can be preserved to the large extent and the combination of electric and acoustic stimulation may provide high levels of speech recognition. This is a very important finding because it supports implementation of the new method of partial deafness treatment.

### References

- [1] C.W. Turner, K.J. Cummings, Speech audibility for listeners with high-frequency hearing loss, *Am. J. Audiol.* 8 (1) (1999) 47–56.
- [2] H.J. McDermott, M.R. Dean, Speech perception with steeply sloping hearing loss: effects of frequency transposition, *Br. J. Audiol.* 34 (6) (2000) 353–361.
- [3] C. von Ilberg, et al., Electric-Acoustic-Stimulation (EAS) of the auditory system. New technology against severe hearing loss, *ORL J. Oto-Rhino-Laryngol. Relat. Spec.* 61 (6) (1999) 334–340.
- [4] J. Kiefer, et al., Fundamental aspects and first results of the clinical application of combined electric and acoustic stimulation of the auditory system, in: T. Kubo, Y. Takahashi, T. Iwaki (Eds.), *Cochlear Implants—An Update*, Kugler Publications, The Hague, Netherlands, 2002, pp. 569–576.
- [5] A. Lorens, et al., Residual acoustic hearing in the ear before and after cochlear implantation, in: K. Jahnke, M. Fischer (Eds.), *4th European Congress of Oto-Rhino-Laryngology Head and Neck Surgery*, vol. 1, Monduzzi, Bologna, 2000, pp. 135–138.

- [6] H. Skarżyński, et al., Preservation of residual hearing in children and post-lingually deafened adults after cochlear implantation: an initial study, *ORL J. Oto-Rhino-Laryngol. Relat. Spec.* 64 (4) (2002) 247–253.
- [7] H. Skarzynski, A. Lorens, A. Piotrowska, A new method of partial deafness treatment, *Med. Sci. Monit.* 9 (4) (2003) CS20–CS24.
- [8] R.W. Harrell, Puretone evaluation, in: J. Katz (Ed.), *Handbook of clinical audiology*, Lippincott Williams and Wilkins, 2002, pp. 71–87.